Stratospheric measurements of ozone-depleting substances and greenhouse gases using AirCores

E. Leedham Elvidge[1], H. Chen[2], P. J. Fraser[3], J. Hatakka[4], P. Heikkinen[4], J. Kaiser[1], R. Kivi[4], T. Laurila[4], T. Röckmann[5], W. T. Sturges[1], C. van der Veen[5], and J. C. Laube[1]

[1]Centre for Ocean and Atmospheric Sciences, School of Environmental Sciences, University of East Anglia, United Kingdom

[2]Center for Isotope Research, University of Groningen, Groningen, The Netherlands

[3]Climate Science Centre, CSIRO Oceans and Atmosphere, Aspendale, Victoria, Australia

[4]Finnish Meteorological Institute, Sodankylä, Finland

[5]Institute for Marine and Atmospheric Research Utrecht, Utrecht University, Utrecht, The Netherlands

The use of AirCores (Karion et al., 2010) to collect stratospheric profiles of CO_2 and CH_4 up to 30 km has been increasing in recent years. AirCores are technically simple and inexpensive to build and deploy, providing an alternative to traditional large stratospheric balloons or aircraft measurements. They consist of long coils (up to 200 m) of lightweight stainless steel tubing that is evacuated on a meteorological balloon-powered ascent and filled during the subsequent descent. AirCores collect whole air samples and thus enable crucial satellite validation for a range of trace gas species, including greenhouse gases. Due to the payload restrictions on small balloons sampled air volumes are small, around 200-300 ml of stratospheric air. This makes analysis of less abundant (ppt range) trace greenhouse gases, such as halocarbons, difficult.

The ERC-funded EXC^{3}ITE project (EXploring stratospheric Composition, Chemistry and Circulation with Innovative Techniques) aims to conduct regular – several flights per season – analysis of up to 30 key greenhouse and ozone depleting substances from AirCore samples. Here we present the first stratospheric measurements of more than 10 halocarbons (including SF_6, CFCs, halons and HCFCs) in AirCores obtained using UEA's highly sensitive (detection limits of 0.01-0.1 ppt in 10 ml of air) gas chromatography mass spectrometry system. The analysed air originates from a stratospheric air sub-sampler (Mrozek et al., 2016), which collects AirCore segments after non-destructive CO_2 and CH_4 analysis. Comparisons with previous high altitude aircraft campaigns show good agreement with our AirCore results for some compounds, e.g. SF_6 and Halon-1211, and for other compounds method development is underway to improve the agreement. Both current results and methodological developments will be presented. For some compounds, analytical uncertainties associated with our AirCore data are already within the range of previous high altitude aircraft and balloon samples analysed at UEA: for example SF_6 AirCore uncertainties are around 0.8% compared to 0.5-1.2% for previous campaigns. This highlights the potential for AirCores data to be used in the derivation of 'mean age of air'. Mean age is used to help determine chemical lifetimes and we hope to use AirCore-derived mean ages to provide better constraints on the stratospheric lifetimes, and therefore the global warming potential, of several non-CO_2 greenhouse gases.

References

Karion et al., J. Atmos. Ocean. Technol., 27(11), 1839–1853, 2010

Mrozek et al., Atmos. Meas. Tech., 9, 5607-5620, 2016